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Increasing female education, stagnating female labor force participation, and gains from marriage: The case of rural Bangladesh

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Abstract

Despite progress toward gender equality in education in Bangladesh, its female labor force participation (FLFP) rate has been stagnant relative to that of men, especially in marginal rural areas. To identify the overall benefit of schooling investment in women in rural Bangladesh, we examine the impact of female educational attainment on not only FLFP but also gains from marriage and household welfare. Applying a fuzzy regression discontinuity design where plausibly exogenous variation in school enrollment is created by the nationwide stipend program for women, we find moderate impacts of female education on FLFP, while it has positive and significant effects on the husband's schooling and household income, particularly from non-farm activities. The results also show the significantly positive impacts of women's education on sanitation control and children's health. These findings indicate that female schooling enhances women's role and well-being through marriage and household activities rather than their labor market activities.

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1. Introduction

Gender equality in education has been globally acknowledged as an important goal for international development. One of the UN Millennium Development Goals is to "promote gender equality and empower women" and an ongoing effort to "achieve gender equality and empower all women and girls" is stressed in the UN Sustainable Development Goals. The empowerment of women, particularly by promoting girls' education, has often been associated with the expectation of increased female labor force participation (FLFP) and reduced early marriage and pregnancy. Since women represent 40% of the global labor force (World Bank, 2012), enhancing women's labor productivity by improving their ability and opportunities in the labor market is indispensable to foster economic growth.

Despite its importance, however, schooling investment has favored boys in many low-income and Muslim societies. One of the recent rare exceptions is Bangladesh, where the school enrollment rate among girls aged between 5 and 19 significantly increased from 33% in 1991 to 56% in 2005 (World Bank, 2012). Bangladesh has also experienced a reversed gender gap in secondary education, with girls now more likely to attend secondary school than boys (Asadullah and Chaudhury, 2009). In contrast to the country's great achievement in gender equality in education, however, the FLFP rate in Bangladesh has increased at a slow pace, from 4% in the 1974 Bangladesh Census to 8% in the 1984 Labor Force Survey and 26% in the 2010 Labor Force Survey (Bridges et al., 2011; Heintz et al., 2017). This is substantially low relative to men whose labor force participation rates were around 85% during the same periods. This is puzzling if the benefit of education is realized primarily through the labor market and raises a question as to why women are keen to invest in high education.

The literature suggests several potential benefits of female education outside the labor market. One is through the marriage market because educated women are more likely to marry a man with a higher education and better earnings capacity through assortative mating (Behrman and Rosenzweig, 2002; Behrman, Rosenzweig, and Taubman, 1994; Foster and Rosenzweig, 2001; Goldin, 1995; Goldin, 1997; Klasen and Pieters, 2015; Lefgren and McIntyre, 2006; Lafortune, 2013). Increased female education is also associated with delayed childbearing and total fertility (Breierova and Duflo, 2004; Chicoine, 2012; James and Vujic, 2019; Ozier, 2015; Tequame and Tirivayi, 2015) and improved children's health (Breierova and Duflo, 2004; Keats, 2018; Güneş, 2015; Currie and Moretti, 2003). In addition to health, maternal education has a significant and positive impact on child schooling (Behrman and Rosenzweig, 2002; Lam and Duryea, 1999; Duflo, 2012). Behrman, Foster, Rosenzweig, and Vashishtha (1999) stress the importance of women's education in the productivity of home teaching, where better educated mothers are superior teachers at home.

Expanding the effect of women's education beyond the labor market, this study examines the impact of increased female schooling on the various lifetime outcomes of women in Bangladesh. Given the moderate increase in FLFP in the country, we hypothesize that women in Bangladesh benefit from their education investment through not only labor force participation but also marriage and reproductive activities. We particularly focus on rural areas that offer limited employment opportunities outside farms and where the traditional norm of the seclusion of women (called *purdah*) requires them to spend long hours inside the home performing household chores, which would further lower FLFP. To address the endogeneity concern of female education, we adopt

a fuzzy regression discontinuity design (RDD) using the nationwide secondary school stipend program implemented for rural girls in 1994 as an external shock.

Our results show the moderate impact of female education on FLFP. We, however, find that an additional year of a wife's schooling significantly increases the husband's schooling and household per capita income, especially that from non-farm sources, indicating the positive gains from marriage by the increased education of women. The increased household income appears not only through assortative mating, but also through better labor allocation, allowing the husband to migrate abroad. The wife's education also has a positive impact on the probability of having healthy children, the probability of using a clean latrine at home, and household expenditure on nutritious food and sanitation items, suggesting that women's improved knowledge about health and sanitation enhances children's health status. Overall, our results suggest that better educated women enjoy a benefit through the concentration of household chores and childcare owing to the higher income earned by their husbands rather than through their own labor market participation.

Our study contributes to the literature on female empowerment through schooling investment in developing countries by assessing the long-term impact of the stipend program on various lifetime outcomes including marriage market returns to women's education (Asadullah and Chaudhury, 2009; Fuwa, 2001; Hong and Sarr, 2012; Khandker et al., 2003; Shamsuddin, 2015). This is still rare for developing countries because most existing studies of this topic concentrate on developed countries in which appropriate panel data are readily available (Anderberg and Zhu, 2014; Lefgren and McIntyre, 2006; McCray and Royer, 2011). Our study is most closely related to Hahn et al. (2018a, 2018b), who examine the impact of female education in Bangladesh using

rural and urban data and an instrumental variable technique combined with the difference-in-differences (DID) methodology.[1] Like theirs, we use the stipend program as a source of exogenous variation to identify the clean impact of female education. Our analysis, however, relies exclusively on sample households in rural areas, where the stipend program was implemented, and examines the detailed mechanisms behind the observed relationships. More specifically, our study is novel as it utilizes rich information on the different sources of household income (farm and non-farm), disaggregated household expenditure, and migration history of husbands to better understand the paths to reap the returns of women's education. To the best of our knowledge, this is the first study to address the impact on such detailed outcomes in rural Bangladesh, which thus complements previous studies.

The rest of the paper is structured as follows. In Section 2, we describe the data used in this study. Section 3 outlines the female secondary school stipend program in Bangladesh used in our analyses. The empirical strategy and estimated results are presented in Sections 4 and 5, respectively. Section 6 concludes.

2. Data

The present study uses a household panel data set for 1988–2014 collected by Dr Mahabub Hossain of the Bangladesh Rural Advancement Committee (BRAC).[2] It covers 62 of the 64 districts in the country and consists of 62 rural villages (i.e., one village

[1] Other studies that examine the impact of the female secondary school stipend program in Bangladesh include Asadullah and Chaudhury (2009), Fuwa (2001), Hong and Sarr (2012), Khandker et al. (2003), and Shamsuddin (2015)

[2] This data set is called the "Livelihood System of Rural Households Panel Data."

represents each district). A multi-stage random sampling method was adopted for the sample selection of these 62 villages for the benchmark survey in 1988 (Nargis and Hossain, 2004; Hossain et al., 2009). Approximately 20 households in each village were randomly chosen as the original sample households.

This panel household survey was conducted in 2000–2001 by the International Rice Research Institute and the same households were revisited in 2004 and 2008. The latest survey was jointly conducted in 2014 by the Bangladesh Rural Advancement Committee and National Graduate Institute for Policy Studies. The panel data cover 1,240 households in 1988, 1,883 households in 2000, 1,927 households in 2004, 2,010 households in 2008, and 2,846 households in 2014. The sample size increases over time, as split households are included in the follow-up surveys.[3] The data contain household information (e.g., amount of owned land, use of fertilizer, and investments in family businesses), individual information (e.g., age, gender, education, and occupation), and village-level information (e.g., distance to district headquarters).

In addition to the basic information, the data set has several unique features. First, it includes detailed time allocation data of selected family members (head, spouse, and one male and female member) for the last four days on the 1) type of activities, 2) time spent on each activity, and 3) wage/income earned by each activity. The detailed information on time allocation is particularly useful to measure women's actual contribution to market production (Heintz et al., 2017; Schultz, 1990). As women in developing countries are often engaged in home-based production or self-employed activities, which are rarely regarded as "work," the official data tend to underreport their economic contribution

[3] As the panel data cover a period of nearly three decades, sample households suffered some attrition. See Online Appendix 1 for our attrition analysis.

(Berniell and Sánchez-Páramo, 2011; Bruhn, 2009; Heintz et al., 2017; Mead and Liedholm, 1998; Schultz, 1990). We overcome this issue by exploiting not only self-reported occupation data, but also time allocation data to define FLFP.

Second, the data record the basic socioeconomic information of migrant family members who were temporarily absent during the survey period. Including migrant family members' information is particularly important in a country such as Bangladesh where international migration is active (Kikkawa et al., 2019). We use these migration data in a later analysis to examine how female education is related to the husband's migration probability, especially foreign migration.

Third, the data cover rich information on different sources of household income (farm and non-farm) and disaggregated household expenditure. This enables us to investigate household resource allocation in detail, including family labor and capital, which could explain a pathway through which female education affects the outcomes of interest.

To examine the long-term impact of the stipend program implemented in 1994, we primarily use the latest survey (2014) in the main analysis.[4] Of the 2,846 households in the 2014 survey, we select 2,565 for which both the wife and the husband are recorded. One in 10 of all households and 1.6% of the subsamples miss either the wife or the husband because of divorce or death.[5] Table 1 shows the summary statistics for these selected couples. Columns (1) and (2) show all 2,565 samples and columns (3) and (4) show the subsamples aged between 25 and 36 years. This age range, described in detail

[4] As the data are paneled at the household level, we did not use pooled data in 1988–2014 for our analysis because there is high probability that the same people were surveyed over time.

[5] Considering the possible selection bias by dropping divorced or widowed women, we repeated the same regression analyses with all 2,846 households and found similar results to those reported in the manuscript.

in Section 4, is mainly used for our analyses because they are near the cutoff of exposure to the stipend program. As shown in column (3), the average age of wives in the subsample is 30.7 years, while that of husbands is 38.2 years. Wives are slightly more educated than husbands; the former with 5.56 years of schooling and the latter with 5.40 years. By contrast, average age at marriage is substantially different; wives get married at the age of 17, while husbands get married at 21.

We define labor force participation in the following two ways: first, a dummy takes the value of one if a woman reported income-generating activities as a primary or secondary occupation; second, a dummy takes one if a woman spent at least one hour on any kind of income-generating activity for the last four days. Under the definition of FLFP in the occupation data, only 9% of the women are in the labor force, implying that the vast majority primarily regard themselves as homemakers. By contrast, according to the definition of the time allocation data, the FLFP rate jumps to 63%, indicating that well over half of the women have contributed to market production, but their contribution is underreported in the occupation data. Because of this large difference between the two data sets, we use both and examine the sensitivity of our results to different definitions.

We must emphasize that although 63% of women are engaged in income-generating activities, only 4% of them receive payment. Thus, the vast majority work as unpaid labor in our sample villages. Average household per capita income is 32,733 taka,[6] with wives' contribution uncertain because of the unpaid nature of their work.

[6] 1 USD = 77.6 taka in 2014 (Global Economic Monitor, World Bank).

3. Gender disparity in schooling and female secondary school stipend program in Bangladesh

The schooling system (grades 1–12) in Bangladesh is categorized into four types of schools: grades 1–5 are called "primary"; grades 6–8, "junior secondary"; grades 9 and 10, "secondary"; and grades 11 and 12 "higher secondary."[7] The academic year in both primary and secondary schools begins in January and ends in December. Officially, the school starting age is 6; however, according to our data in 1988, 47% of children aged 8 were either in grade 1 or still illiterate, indicating that delayed entry to primary school and grade repetition are common.

3.1 Gender disparity in schooling before the stipend program

Low educational achievement among women in Bangladesh has been recognized by international organizations and the Bangladeshi government at least since the early 1990s. For example, the World Bank reports that the literacy rate among women in 1990 was only 22%, while that of the total population was 35% (World Bank, 1992). According to our data in 1988, there was a clear gender disparity in the school enrollment rate before the introduction of the stipend program in 1994. Figure 1 shows the ratio of girls and boys, by age group, enrolled in a school in 1988, 2000, and 2014. In 1988, the school enrollment rate of girls was lower than that of boys at all ages. The gap between girls and boys was particularly pronounced at secondary school ages (11–15 years). Girls' enrollment rate

[7] Associated with the different levels of education, Bangladesh has four terminal exams, starting at the primary level (Primary Education Completion Exam), followed by the junior secondary level (Junior School Certification), secondary level (Secondary School Certification), and higher secondary level (Higher Secondary Certification).

dropped from 70% to less than 40% in transition from primary to secondary school between 11 and 15 years, while that of boys fell from 80% to over 50%.

3.2 Female secondary school stipend program

In response to this gender disparity at the secondary school level in Bangladesh, the nationwide female secondary school stipend program was implemented to raise school enrollment among rural girls.[8] The program objectives include (1) improving secondary school attainment among girls, (2) promoting female employment and labor force participation, and (3) reducing early marriage and avoiding early pregnancy. The program combines four uniform projects under different donors: the Female Secondary School Project by the Bangladeshi government, Female Secondary School Assistant Project by the World Bank and Bangladeshi government, Secondary Education Development Project by the Asian Development Bank and Bangladeshi government, and Female Secondary Education Project by the Norwegian government. These four projects share the same stipend scheme (including stipend amount and eligibility criteria) and same project objectives; hence, they can be regarded as a single uniform stipend program. As the program targets rural areas, the 30 metropolitan *thanas* in Khulna, Dhaka, Chittagong, and Rajshahi are excluded (Schurmann, 2009). Thus, the project covers 460 of the 490 *thanas* in the country. The program was officially introduced in January 1994 in all 460 *thanas*, and 98% of all rural secondary schools in which girls enrolled became part of this program by 1998 (Khandker et al., 2003).[9]

[8] In the same vein, a similar pilot project has been implemented in a small part of the country since 1982. Meanwhile, a free tuition policy was introduced to grades 6–8 in 1990 in rural *thanas*.

[9] Although the program was official implemented in January 1994, there was a delay to either 1995 or 1996 in some schools (Fuwa, 2001; Khandker et al., 2003). However, detailed information on which schools

The targeted population of the program was girls in grades 6 to 10 (aged 11 to 15), including those already enrolled in the first-year of secondary school. Girls who can attend a secondary school in rural areas and who meet the following criteria are eligible to receive a stipend and tuition subsidy: (1) attend at least 75% of school days, (2) attain at least a 45% mark in the annual examination, and (3) remain unmarried. Thus, this stipend program is a conditional cash transfer scheme. According to Khandker et al. (2003), only 6% of secondary school girls fail to satisfy these criteria. The stipend covers 50% of the costs of schooling items such as textbooks, uniforms, and stationery as well as other expenses such as transportation and exam fees (approximately 25–60 taka per month). Moreover, the program subsidizes the full tuition cost, ranging from 10 to 20 taka per month, depending on grade (Fuwa, 2001). The stipend is paid directly into an account in the girl's name at the nearest Agrani Bank, a state bank with branches nationally.[10]

Figure 1 shows the immediate changes in the school enrollment rate after the introduction of the stipend program. In 2000, the school enrollment rate at primary school ages (6–10 years) was nearly 90% for both girls and boys and that of secondary school ages was higher among girls than boys. Girls at age 15 reported a 75% school enrollment rate, while that for boys of the same age was less than 55%. The reversed gender gap in secondary school enrollment continued in 2014.

delayed starting the program is not publicly available. Therefore, in this study, we assume that the program was uniformly implemented in January 1994.

[10] In addition to the stipend and tuition subsidy, the program also offered technical assistance to improve the quality of schools such as curriculum reforms, instructional material development, teacher training, recruitment of female teachers, improvement of school infrastructure, community awareness programs, and institutional capacity building. Unlike the stipend and tuition subsidy, however, this technical support differed depending on the donor (Fuwa, 2001). Other potential barriers to sending girls to a secondary school such as accessibility (which could be enhanced by constructing new secondary schools in a village or nearby village or providing decent transportation to travel to a school) and domestic work burden (which could be reduced by time-saving infrastructure such as electricity and tube water), these were not covered by the program. Nonetheless, the program at least removed one financial barrier as well as increased public awareness of the importance of girls' secondary education.

4. Estimation strategy

This study examines the causal effects of women's education on various lifetime outcomes. Unlike the studies by Hahn et al. (2018a, 2018b), our sample covers only those rural areas in which the female secondary school stipend program was implemented. Thus, the DID methodology, using urban areas as a comparison group, is infeasible. Moreover, an ordinary least squares estimate is likely to be biased because of unobserved factors such as individual "ability" that affect both educational attainment and the outcomes of interest (Lefgren and McIntyre, 2006). We thus employed a fuzzy RDD by exploiting the timing of the introduction of the stipend program as a plausible exogenous shock. Specifically, we divided our sample into two groups: the treatment group was exposed to the stipend program, whereas the control group did not benefit from it based on the year in which the program was first implemented. As treatment status was assigned based on an observed forcing variable, namely age, we assume that whether an individual is treated is completely random near the cutoff point.

Table 2 presents details on the eligibility of the stipend program of each birth cohort. To summarize, girls born before 1980 (women aged above 34 in 2014) were not covered by the program and girls born between 1980 and 1982 (women aged between 31 and 34) were partially covered given that the program entry grade was fixed to grades 6 and 9 for junior secondary and secondary schools, respectively. In other words, girls in grades 7 and 8 in 1994 and girls in grade 8 in 1995 were not covered by the program, as they had to wait until grade 9 to receive the program benefit. This is indicated by the non-highlighted parts in Table 2. All girls born after 1983 (women aged 30 or younger) benefited from the stipend program fully. Therefore, we set the cutoff point at age 30 in 2014.

In our fuzzy RDD, the treatment and control groups are classified based on the probability of being treated compared with a sharp RDD in which the treatment group is clearly differentiated from the control group based on actual treatment receipt. This is because some girls in the treatment group did not receive the treatment. As the stipend program was available for girls who *actually attended* a secondary school at the time of implementation (in other words, compliers), those at the eligible age who chose not to proceed to secondary education did not benefit from the program (Imbens and Lemieux, 2008). In addition, some girls received the stipend despite being categorized into the control cohorts. For example, some of the 1980–1982 cohorts, who attended class 9 in 1994 (Table 2), partially benefited from the program. Similarly, some of the control cohorts who attended class 6 in 1994 also benefitted because of grade repetition and delayed entry.[11]

Figures 2(a) and 2(b) plot the average years of education by age group and show the fitted lines for wives and husbands, respectively. The vertical line indicates the cutoff point at age 30. As expected, there is a sharp upward jump (discontinuity) for wives at the age cutoff point. At the cutoff, women exposed to the stipend program attained on average nearly one additional year of schooling. However, no such upward jump can be observed for husbands at the same age cutoff. Although there is large heterogeneity in the average years of education among husbands aged below 30 (left-hand side of the cutoff), the fitted line indicates the decrease in education, which is consistent with the findings of previous studies that the stipend program has led to reversed gender disparity at the secondary level (Fuwa, 2001; Khandker et al., 2003; Asadullah and Chaudhury, 2009).

[11] We discuss whether there was strategic grade repetition or delayed entry to receive the stipend along with other internal validity tests in Online Appendix 2.

Likewise, Figures 2(c) and 2(d) illustrate scatterplots of years of education, by age, with a bin size of 3. Again, the sharp discontinuity at the cutoff is observed for wives but not for husbands.

Given the observed discontinuity in a wife's years of education at the age cutoff point, we restrict the analysis to a sample near the cutoff and apply fuzzy RDD. This assumes that the age cohorts near the age cutoff point share similar characteristics, so that any difference in outcomes can be attributed to the stipend program. Let *Y* be the outcome of interest; *Educ*, the educational attainment of women; *x*, age; and *c*, the cutoff. Following Imbens and Lemieux (2008), the causal effect of an additional year of schooling in the fuzzy setting τ is defined as

$$\tau = \frac{\lim_{x \to -c} E[Y|Age = x] - \lim_{x \to +c} E[Y|Age = x]}{\lim_{x \to -c} E[Educ|Age = x] - \lim_{x \to +c} E[Educ|Age = x]} \ , \qquad (1)$$

where the limits from the left and right are taken for the range $c - h < x < c + h$ with some bandwidths *h*. As suggested by Hahn et al. (2001), the treatment effect in this setting should be estimated using two-stage least squares (2SLS):

$$Y_{js} = \alpha + \beta \widehat{Educ_{ijs}} + f\left(Age_{ijs} - c\right) + X_s \delta_Y + v_{js} \ , \qquad (2)$$

$$Educ_{ijs} = \gamma + Treat \times \left(\pi + g\left(Age_{ijs} - c\right)\right) + g\left(Age_{ijs} - c\right) + X_s \delta_{Educ} + \epsilon_{ijs} \ , \qquad (3)$$

where Y_{js} represents the outcome of interest of household *j* in village *s*. $Educ_{ijs}$ is the years of education of wife *i* in household *j* in village *s*; Age_{ijs} is the age of the wife; and village dummies X_s are also included to capture the difference in the characteristics of the marriage market in each village. $Treat = 1\left[Age_{ijs} \leq 30\right]$, and $f(\cdot)$ and $g(\cdot)$ are functions of the order of the polynomials. Here, we employ the first-order polynomial, as none of the higher-order polynomials are significant. The interaction term between

$Treat$ and $g(\cdot)$ is included to allow the regression function to differ on both sides of the cutoff point (Lee and Lemieux, 2010). Moreover, $Age_{ijs} - c$ instead of Age_{ijs} is used to make the interpretation easier by centering the forcing variable. v_{js} and ϵ_{ijs} are random error terms. Following Imbens and Lemieux (2008) and Lee and Lemieux (2010), standard errors are computed using robust 2SLS standard errors and clustered at the cohort (age) level. In this framework, β represents the causal effect of an additional year of a wife's education on the outcomes. The treatment effect is a local average treatment effect.

To select the optimal bandwidths, h, we use the cross-validation methods (Imbens and Lemieux, 2008) and several bandwidth selection procedures proposed by Calonico et al. (2014, 2017). Figure A1 in the Appendix shows the results of the cross-validation procedure. The cross-validation function sharply declines when we include three age cohorts from the left-hand and right-hand sides of the cutoff, and it increases rapidly after including six age cohorts from each side. Meanwhile, the estimated bandwidths vary from 2 to 7 and from 2 to 15 for the left-hand and right-hand sides of the cutoff, respectively. Based on these results, we employ bandwidths from 3 to 6 in our analysis. The order of the polynomials and bandwidth are the same in both the first and second stages.

5. Results

5.1 Correlation between the stipend program and educational attainment

Table 3 documents the results of the first-stage regression, which shows the relationship between the stipend program and educational attainment of wives in our sample. Exposure to the female secondary school stipend program has significantly increased

women's education, which is consistent with its aim. The results suggest that a woman eligible for the program obtains about 1.2 years more schooling than one not exposed, which is equivalent to a 24% increase relative to women on the right-hand side of the cutoff. Compared with the findings of existing studies that the program increases women's years of education by 0.36–2.0 years (Hong and Sarr, 2012; Shamsuddin, 2015), our results seem reasonable.

Table 4 presents the disaggregated impact of the stipend program. As discussed in the previous section, the stipend program covering grades 6–8 was available for women aged 30 or below, whereas the one covering grades 9 and 10 was offered to women aged 33 or below (see Table 2). Using the difference in grades covered by the program among cohorts, we create another treatment dummy variable that takes one if the wife's age is 33 or below and include two treatment dummies as well as the corresponding interaction terms with age to assess whether there is any difference in the impact on female schooling. As shown in Table 4, while treatment status in grades 6–8 has a positive and statistically significant impact on the wife's years of schooling, the coefficients of treatment status in grades 9 and 10 are positive but not statistically significant except bandwidth 8. These findings indicate that the stipend program has a larger effect on lower grades. The results also confirm that the effects for partially affected cohorts (born in 1980–1982) are negligible; therefore, it is reasonable to set the cutoff age at 30.

5.2 Effect of education on age at marriage and FLFP

Having shown that the stipend program is significantly correlated with the wife's educational attainment, we now examine the effect of women's education on the primary

objectives of the stipend program: age at marriage and FLFP.[12] We use two FLFP dummies defined by the occupation data and time allocation data. Table 5 presents the estimation results.

Somewhat surprisingly, our estimation results show no impact on age at marriage and a negative impact on FLFP when we use the occupation data. Regarding age at marriage, the coefficients of a wife's years of education in columns (1)–(4) of Panel A are mostly positive but not statistically significant. Meanwhile, the effects of the same variable on FLFP shown in columns (1)–(4) of Panel B are negative and statistically significant for some bandwidths. As shown by the coefficient in column (4) of Panel B, an additional year of schooling reduces the probability of FLFP by roughly 7 percentage points. However, when we use the time allocation data (see Panel C), we find positive effects of women's schooling on FLFP, although the coefficient is only statistically significant at the 10% level in the estimation with a bandwidth of 4.[13] Overall, our results suggest no effect or at best a moderate impact of female education on age at marriage and labor force participation.[14]

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[12] Online Appendix 3 presents the definition and summary statistics of all the outcome variables.

[13] As a robustness check, we regressed the two FLFP dummies on years of schooling using the full sample of women, including women whose husband's information is missing (e.g., those widowed, separated, or divorced and those recorded as the "daughter," "granddaughter," or "other relative" of the household head) rather than restricting only to wives. Table A1 in the Appendix shows the results of the first- and second-stage regressions. The estimated coefficients are not statistically significant for both FLFP dummies.

[14] We also examined whether the negative and significant impact on FLFP that we find with the occupation data shows the pure impact. As we explain later, women with higher education are more likely to marry men with higher earning capacities. Thus, this negative sign may partly capture the income effect. To check whether this is plausible, we conducted a mediation analysis in which household income and the husband's education were included as additional regressors. We found that although the sign is still negative, female

These results contrast with the findings in the literature, which reports that the higher female educational attainment induced by the stipend program has a positive and statistically significant impact on FLFP and age at marriage (Hahn et al., 2018a, 2018b; Hong and Sarr, 2012; Shamsuddin, 2015). One of the possible reasons for this difference might be the difference in methodologies used and coverage of the data set, since Hahn et al. (2018a, 2018b), Hong and Sarr (2012), and Shamsuddin (2015) all employ a DID estimation with data on both rural and urban areas.

Indeed, the jobs available to women and their characteristics in urban and rural Bangladesh differ markedly. In urban areas, the development of the garment industry, for instance, has provided new employment opportunities to educated women (Heath and Mobarak, 2015), which are rarely available in rural areas. Although it is possible for rural women to work in a garment factory in urban areas through migration, *purdah* norms in rural areas often limit women's mobility and discourage them from migrating alone (Heintz et al., 2017; Kabeer, 2017; Kabeer and Mahmud, 2004). Indeed, the time allocation data show that the vast majority of women spend their time on farming activities such as poultry and livestock rearing and post-harvest work aside from housework. Even if women are engaged in non-farm activities, they are generally occupations that do not require advanced knowledge, such as running small businesses, working in service, and conducting work in a cottage industry. Thus, the impact of education on FLFP would be limited in our sample, which covers only rural areas.

education is no longer a statistically significant predictor of FLFP. Together with the moderate impact from the time allocation data, we conclude that the impact of female education on FLFP is moderate in our sample.

5.3 Effect of education on gains from marriage

We now analyze another important return to female education, gains from marriage. Columns (1)–(4) of Panel A in Table 6 show the linear effect of a wife's education on the husband's years of schooling. The results suggest that an additional year of education of wives is associated with an increase in the husband's education by almost one year. As the average education of husbands in this subsample was 5.05 years, a one-year increase is equivalent to a 19.9% rise in the husband's schooling. The positive impact of a wife's education on household per capita income is observed in columns (1)–(4) of Panel B. Household income can be directly affected by the stipend program if an educated wife contributes to family income. To avoid endogeneity between household income and the wife's labor force participation, we thus restrict our sample to wives outside the labor market according to the occupation data (92% of the sample; see Panel B in Table 6). Thus, the observed impact on household income can be considered to be that earned by family members other than the wife. The results indicate that an extra year of education of wives leads to an increase in per capita household income of 5382.5–8403.0 taka. The magnitude of this impact is equal to an 18–26% increase from the mean.

We decompose household income into farm (e.g., crop, rice, forestry, fish, and farm wage income) and non-farm incomes (e.g., remittance, business, service, industry, and non-farm wage income). According to the estimation results in columns (1)–(4) of Panels A and B in Table 7, a wife's education significantly increases non-farm income, while there is no significant impact on farm income. Thus, the increased household income is mainly attributed to the increase in non-farm activities by the husband and other household members.

As our estimation removes wives' direct income contribution, at least two channels may exist through which female schooling affects household income. First, education would enable women to marry men who have the potential to earn a high income. As shown in Panel A of Table 6, there is a positive impact of wives' schooling on husbands' educational attainment. If education is a signal of the income-generating ability of husbands, wives' education would increase household income through assortative mating. Second, women's education would increase household income indirectly through better household resource allocation. As the majority of wives in our sample are homemakers, their education may enhance the productivity of other household members by assisting their activities.

Although direct investigation is difficult, we examine the effect of a wife's education on the husband's decision to migrate overseas to explore the plausibility of the latter channel. In our rural sample, the majority of foreign migrants are temporal ones. They often migrate to countries in Asia and the Middle East and are away from home for several years due to high placement costs (Kikkawa et al., 2019). In such a household in which the husband spends most of his time overseas, his wife may have to play the role of the household head on his behalf. Moreover, a migrant husband often has to rely on his wife to use the remittances he sends home. Thus, women's education could contribute to household income indirectly through their high capability to manage the household.

Our foreign migration dummy captures both current foreign migrants and returnees. As shown in column (2) of Panel C in Table 7, the husband's probability of being a foreign migrant rises by 6 percentage points with an additional year of schooling for wives. Although the coefficient is only statistically significant at the 10% level in the estimation with a bandwidth of 4, our result suggests that wives' educational attainment

has positive impacts on household income indirectly by enhancing the allocation of labor.[15]

5.4 Estimates of the effect of education on household welfare

In this subsection, we explore the consequences on household welfare such as health, education, sanitation, nutrition, expenditure, and decision-making authority among household members.

Columns (1)–(4) of Panel A in Table 8 show the results for fertility. As we cannot observe total fertility for the sample women (ages 25–36), we define fertility as the number of births by age 23. Although delayed childbearing does not necessarily reduce the total number of children (Balasch and Gratacos, 2012), the variable can capture the tendency of an early pregnancy. None of the coefficients of the variable of interest are statistically significant, indicating that education does not affect women's reproductive activity at early age; however, this does not necessarily mean that education does not affect fertility.

Columns (1)–(4) of Panel B report the causal effect of a wife's education on a young family member's schooling dummy, which takes one if any family member aged between 15 and 22 attends school and zero otherwise. We do not restrict the sample to biological children because the sample women are too young to have children of higher secondary or tertiary school age. As a compromise, we examine the impact on the schooling of any family member aged 15–22, including sisters- and brothers-in-law who live in the same household. The estimation results in columns (1)–(4) of Panel B show

[15] We also examine domestic migration by husbands and find no significant impact.

the mixed impact of women's education on the schooling of any child in the household. The signs of the coefficients vary across bandwidths, preventing us from drawing a clear conclusion about the impact on the dependent variable. Indeed, the influence of women's education may be limited to their own biological children.

Columns (1)–(4) of Panel C show the effect of a wife's years of education on the use of a latrine with a water seal. In our sample villages, some households still use open toilets or hanging latrines near a river or lake and clean the sanitary station after use only infrequently. However, no special facility is needed to maintain a clean toilet since the water used for cleaning comes from a nearby well. Thus, the level of sanitation highly depends on household members' awareness of sanitation. Our finding indicates that an additional year of education for wives improves the probability of using a toilet with a water seal by 16 percentage points. Since 57% of subsample households use this type of latrine, this impact is equivalent to a 28% increase in use.

To capture the health status of children, we create a dummy variable that takes one if a child reports being "sometimes sick" or "hardly ever sick" and zero if she/he reports being "almost always sick." Columns (1)–(4) of Panel D present the effect of wives' education (here mothers' education) on the children's health dummy, which is positive and statistically significant. The estimated coefficients suggest that if the mother's education increases by one year, children's probability of being healthy increases by 14 percentage points.[16]

Our findings on sanitation control and children's health are consistent with the results of household expenditure and its use. Table 9 presents the impact of wives'

[16] In our subsample, nearly 90% of the children report that they are healthy. Thus, the actual impact of women's education on children's health is moderate in relative terms.

education on different weekly expenditure categories. Total household expenditure, shown in columns (1)–(4) of Panel A, increases by 765.7 taka with each extra year of schooling. We also disaggregate total expenditure by use. For example, weekly expenditure on nutritious food items comprises all expenditure on fruit and vegetables, meat, and eggs. Expenditure on sanitation items includes spending on soap, detergent, and related items. Medical expenditure covers the cost of medical care and medicine. Columns (1)–(4) of Panels B–D show that women's education significantly increases all three expenditure categories. It is less likely for a husband to decide purchases such as daily food and sanitary items because most household tasks such as cooking and laundry are carried out by women. Therefore, the findings on expenditure confirm the contribution of women's schooling to improving household welfare such as sanitation control and children's health.

6. Conclusions

In this study, we examined the causal effect of women's educational attainment on the various lifetime outcomes of women beyond the formal labor market. To address the potential endogeneity and unobserved heterogeneity of education, we applied a fuzzy RDD to approximate real randomization. Using the nationwide female secondary school stipend program introduced in 1994 as a source of exogenous variation, we identified the effects of women's schooling on FLFP, gains from marriage, and household welfare.

In the context of the long stagnation of FLFP in rural Bangladesh, only a moderate impact of women's education on FLFP was observed. By contrast, significantly positive effects of a wife's schooling on the husband's education and household income were found, which were attributed to the increase in non-farm activities, including the

husband's foreign migration. The magnitude is rather large, with household income rising by 18–26% for each additional year of female education, indicating that the results are not only statistically significant, but also economically significant. This study further investigated the impact of a wife's education on household welfare such as sanitation control and children's human capital. The results suggested that a wife's education had a positive effect on the household's probability of using a clean latrine and the probability of biological children being healthy, while it had no effect on the probability of any young family member being at school. We also found a positive impact of a wife's schooling on household expenditure on nutritious food and sanitation items, which could partially contribute to the positive outcome of children's health. These findings indicated that female schooling enhances women's well-being through various channels such as marriage and non-market household activities rather than through their own labor market activities.

The study suggests two important implications for female education and its returns. First, a modest increase in female education may be a necessary but not sufficient condition for promoting FLFP. The literature has explained the relationship between female schooling and labor force participation. For instance, Goldin (1997) shows the importance of the emergence of *highly* educated women and development of white-collar jobs for women for driving FLFP. In rural Bangladesh, both factors are rare. Further, female school attainment in tertiary education is still far behind that of male attainment (United Nations, 2014). Moreover, available employment opportunities for women in rural villages are restricted to blue-collar and self-employment jobs (e.g., service and cottage industries). Decent employment options for educated women are schoolteacher and NGO worker, but these fields are highly competitive in rural areas.

Second, despite the moderate impact of women's schooling on FLFP, investing in female education is still important to improve women's well-being, as we observed its positive effects on husbands' education, household income, and children's health. Although it is still too early to conclude its impact on future generations (as their children are still young), it seems reasonable to expect an intergenerational transfer of benefits from the stipend program for schooling to labor outcomes in the future.

For policymakers, particularly those who expect significant monetary returns to investment in female secondary schooling accrued from women's labor market activities, our findings must be used to understand the constraints in rural labor markets fully. In all likelihood, to promote FLFP, a broader analytical framework that encompasses both the supply and the demand factors of female labor force will be required to deepen our understanding of the key determinants of FLFP in developing countries in general and in Bangladesh in particular.

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Tables

Table 1
Summary Statistics of Selected Variables

	(1)	(2)	(3)	(4)
	Full sample		Subsample (24<wife's age<37)	
	Mean	Standard deviation	Mean	Standard deviation
Wife's age	39.59	12.53	30.70	3.59
Wife's years of education	4.28	3.86	5.56	3.79
Wife's age at marriage	16.87	2.64	17.33	2.66
Wife's labor force participation defined by the occupation data (=1 if she reported a primary or secondary occupation regarded as an economic activity)	0.07	0.26	0.09	0.28
Wife's labor force participation defined by the time allocation data (= 1 if she spent at least one hour on paid/unpaid work for the last four days)	0.66	0.48	0.63	0.48
Fertility by wife age 23	0.97	0.86	1.35	0.84
Husband's age	47.42	13.70	38.21	5.99
Husband's years of education	4.80	4.70	5.40	4.74
Husband's age at marriage	22.06	7.27	21.00	8.67
1= if Muslim	0.92	0.27	0.91	0.29
Owned land of household (ha)	0.40	0.72	0.27	0.63
Log of non-land fixed assets	8.91	1.68	8.78	1.61
1= if access to electricity	0.73	0.44	0.73	0.45
Household per capita income (100 Tk)	362.79	321.37	327.33	282.19
Observations (no.)	2565	2565	933	933

Table 2
Eligibility of the Cohort for the Female Secondary School Stipend Program

Year	Birth year									
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1990	8	7	6	5	4	3	2	1		
1991		8	7	6	5	4	3	2	1	
1992		9	8	7	6	5	4	3	2	1
1993		10	9	8	7	6	5	4	3	2
1994			10	9	8	7	6	5	4	3
1995				10	9	8	7	6	5	4
1996					10	9	8	7	6	5
1997						10	9	8	7	6
1998							10	9	8	7
								10	9	8
									10	9
										10
Age in 2014	37–36	36–35	35–34	34–33	33–32	32–31	31–30	30–29	29–28	28–27

Notes: Highlighted parts indicate the eligible grade covered by the stipend program.

Table 3
The Impact of the Female Secondary School Stipend Program on a Wife's Years of Education: Results of the First-stage Regression

	(1) BW3	(2) BW4	(3) BW5	(4) BW6
Treatment = 1	1.240**	1.173**	0.852*	0.837**
	(0.467)	(0.390)	(0.429)	(0.359)
Treat*(Age – 30)	-0.312	-0.299	-0.012	0.024
	(0.222)	(0.176)	(0.115)	(0.081)
(Age – 30)	0.144	0.067	-0.118	-0.150**
	(0.143)	(0.117)	(0.106)	(0.053)
Constant	2.932	3.002*	3.114***	3.033***
	(1.562)	(1.427)	(0.876)	(0.670)
F-statistics	7.84	5.48	2.04	2.73
Mean of dep. var. on right of the cutoff	5.09	5.06	5.01	4.85
Observations (no.)	455	573	724	933

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4
The Disaggregated Impact of the Female School Secondary Stipend Program on a Wife's Years of Education

	(3) BW5	(4) BW6	(5) BW7	(6) BW8
Treatment in grades 6–8	1.133**	1.219***	1.309***	1.362***
	(0.405)	(0.373)	(0.345)	(0.312)
Treatment in grades 9 and 10	-0.408	0.278	0.520	0.937**
	(0.471)	(0.286)	(0.327)	(0.429)
Treat*(Age – 30)	-0.185	-0.216	-0.256	-0.273*
	(0.194)	(0.165)	(0.160)	(0.155)
Treat*(Age – 33)	0.674*	0.280	0.213	0.026
	(0.362)	(0.168)	(0.181)	(0.172)
(Age – 30)	-0.619*	-0.189***	-0.081	0.122
	(0.276)	(0.058)	(0.100)	(0.096)
(Age – 33)	omitted	omitted	omitted	omitted
Constant	5.291***	3.219***	2.752***	1.797**
	(1.390)	(0.627)	(0.697)	(0.756)
Observations (no.)	724	933	1018	1141

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5
The Impact of a Wife's Years of Education on Age at Marriage and FLFP: Results of the Second-stage Regression (2SLS)

	(1) BW3	(2) BW4	(3) BW5	(4) BW6
Panel A: Age at marriage				
Years of education	0.120	-0.042	0.222	0.305
	(0.283)	(0.131)	(0.510)	(0.462)
(Age – 30)	-0.015	-0.089*	0.046	0.037
	(0.117)	(0.047)	(0.161)	(0.131)
Husband's age	0.016	0.009	-0.013	0.007
	(0.038)	(0.035)	(0.039)	(0.029)
Constant	17.224***	18.183***	17.012***	15.389***
	(1.239)	(1.377)	(1.338)	(1.387)
Observations (no.)	453	569	720	929
Mean of dep. var. on right of the cutoff	17.18	17.11	17.10	17.20
Panel B: 1 = FLFP defined by the occupation data (women reported a primary or secondary occupation regarded as an economic activity)				
Years of education	-0.037**	-0.004	-0.064	-0.076**
	(0.019)	(0.029)	(0.050)	(0.036)
(Age – 30)	0.007	0.006	-0.011	-0.015*
	(0.006)	(0.011)	(0.014)	(0.008)
Husband's age	-0.000	0.002	0.001	0.000
	(0.001)	(0.002)	(0.003)	(0.002)
Constant	0.506**	0.305*	0.405	0.404**
	(0.201)	(0.178)	(0.271)	(0.201)
Observations (no.)	455	573	724	932
Mean of dep. var. on right of the cutoff	0.11	0.11	0.11	0.10
Panel C: 1 = FLFP defined by the time allocation data (women spent at least one hour on paid/unpaid work for the last four days)				
Years of education	0.033	0.046*	0.046	0.024
	(0.033)	(0.025)	(0.041)	(0.044)
(Age – 30)	0.027***	0.037***	0.028**	0.023**
	(0.010)	(0.009)	(0.013)	(0.010)
Husband's age	0.002	-0.002	-0.001	-0.001
	(0.008)	(0.007)	(0.005)	(0.003)
Constant	0.132	0.247	0.304	0.445
	(0.499)	(0.419)	(0.310)	(0.271)
Observations (no.)	420	527	671	869
Mean of dep. var. on right of the cutoff	0.62	0.64	0.63	0.63

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6
The Impact of a Wife's Years of Education on the Husband's Education and Per Capita Household Income: Results of the Second-stage Regression (2SLS)

	(1) BW3	(2) BW4	(3) BW5	(4) BW6
Panel A: Husband's years of education				
Years of education	1.062***	0.996***	0.980***	1.045***
	(0.283)	(0.179)	(0.313)	(0.297)
(Age – 30)	0.007	0.019	0.018	0.040
	(0.093)	(0.063)	(0.087)	(0.072)
Constant	-3.855	-2.784	-3.173	-3.921**
	(2.682)	(2.169)	(1.965)	(1.633)
Observations (no.)	455	573	724	933
Mean of dep. var. on right of the cutoff	5.33	5.42	5.37	5.40
Panel B: Per capita household income (100 Tk)				
Years of education	56.317***	53.825***	79.071*	84.030**
	(21.451)	(15.296)	(43.824)	(41.519)
(Age – 30)	4.979	6.277	17.909	19.813
	(5.899)	(4.397)	(14.169)	(12.236)
Constant	11.909	28.122	-3.155	-86.550
	(146.088)	(130.815)	(104.506)	(86.103)
Observations (no.)	418	519	660	853
Mean of dep. var. on right of the cutoff	288.61	306.64	304.31	325.71

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Number of working age members (15<age<60) within a household is controlled in Panels B–D. Husband's age is included in Panels A–D.

Table 7
The Impact of a Wife's Years of Education on the Husband's Migration, Electrification, and Assortative Mating: Results of the Second-stage Regression (2SLS)

	(1) BW3	(2) BW4	(3) BW5	(4) BW6
Panel A: Per capita household farm income (100 Tk)				
Years of education	3.965	15.426	12.669	14.623
	(13.590)	(10.495)	(17.790)	(20.432)
(Age – 30)	-2.694	2.590	0.594	2.740
	(6.891)	(3.726)	(5.945)	(5.716)
Constant	-35.908	-93.365	-93.419	-55.324
	(95.091)	(100.626)	(71.361)	(67.884)
Observations (no.)	418	519	660	853
Mean of dep. var. on right of the cutoff	109.88	120.75	124.33	127.63
Panel B: Per capita household non-farm income (100 Tk)				
Years of education	52.352***	38.399**	66.402	69.406*
	(19.037)	(19.269)	(43.497)	(37.976)
(Age – 30)	7.673	3.687	17.315	17.073
	(5.611)	(4.621)	(13.689)	(10.912)
Constant	47.817	121.486	90.264	-31.226
	(132.616)	(121.020)	(122.698)	(97.272)
Observations (no.)	418	519	660	853
Mean of dep. var. on right of the cutoff	178.73	185.89	179.99	198.08
Panel C: 1 = if husband is a foreign migrant				
Years of education	0.061	0.058*	0.047	0.055
	(0.048)	(0.033)	(0.035)	(0.041)
(Age – 30)	0.018	0.019	0.012	0.018
	(0.019)	(0.016)	(0.011)	(0.012)
Constant	0.298*	0.367***	0.311***	0.302**
	(0.164)	(0.120)	(0.116)	(0.117)
Observations (no.)	449	565	715	922
Mean of dep. var. on right of the cutoff	0.06	0.07	0.06	0.07

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. % of non-farm village labor force and number of working age members (15<age<60) within a household are included in Panel A. Husband's age is included in Panels A and B.

Table 8
The Impact of a Wife's Years of Education on Fertility, Children's Schooling, Sanitation Control, and Children's Health: Results of the Second-stage Regression (2SLS)

	(1) BW3	(2) BW4	(3) BW5	(4) BW6
Panel A: Number of births by wife age 23 (Fertility by wife age 23)				
Years of education	-0.029	-0.043	0.049	0.057
	(0.064)	(0.050)	(0.076)	(0.055)
(Age – 30)	-0.022	-0.035**	0.000	0.000
	(0.023)	(0.017)	(0.025)	(0.027)
Constant	1.978***	1.896***	1.426***	1.182**
	(0.443)	(0.410)	(0.385)	(0.527)
Observations (no.)	455	573	724	933
Mean of dep. var. on right of the cutoff	1.38	1.40	1.41	1.39
Panel B: 1 = if any family member aged between 15 and 22 is in schooling				
Years of education	0.010	0.051**	-0.012	0.030
	(0.033)	(0.021)	(0.031)	(0.046)
(Age – 30)	0.004	0.076**	0.021	0.039*
	(0.044)	(0.031)	(0.034)	(0.020)
Constant	-1.285***	-0.825	-0.442	-0.742***
	(0.445)	(0.513)	(0.433)	(0.158)
Observations (no.)	71	108	147	282
Mean of dep. var. on right of the cutoff	0.57	0.67	0.69	0.67
Panel C: 1 = if using a latrine with a water seal				
Years of education	0.109***	0.161***	0.101**	0.097
	(0.021)	(0.040)	(0.050)	(0.062)
(Age – 30)	0.012	0.041*	0.019	0.020
	(0.017)	(0.021)	(0.012)	(0.013)
Constant	-0.025	-0.228	-0.004	-0.017
	(0.155)	(0.251)	(0.276)	(0.263)
Observations (no.)	455	573	724	933
Mean of dep. var. on right of the cutoff	0.51	0.57	0.56	0.56
Panel D: if child aged between 0 and 5 is healthy				
Years of education	0.106*	0.058	0.139**	0.089**
	(0.063)	(0.047)	(0.066)	(0.043)
(Age – 30)	0.017	0.014	0.038*	0.017*
	(0.032)	(0.026)	(0.023)	(0.010)
Constant	0.150	0.707***	0.481	0.712***
	(0.508)	(0.225)	(0.383)	(0.254)
Observations (no.)	294	347	465	583
Mean of dep. var. on right of the cutoff	0.91	0.90	0.89	0.91

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Number of siblings aged 0–5 and number of siblings aged 6–18 are included in Panel B. Husband's age is included in Panels A, B, and D. Age dummies of children are included in Panels B and D.

Table 9
The Impact of a Wife's Years of Education on Weekly Expenditure: Results of the Second-stage Regression (2SLS)

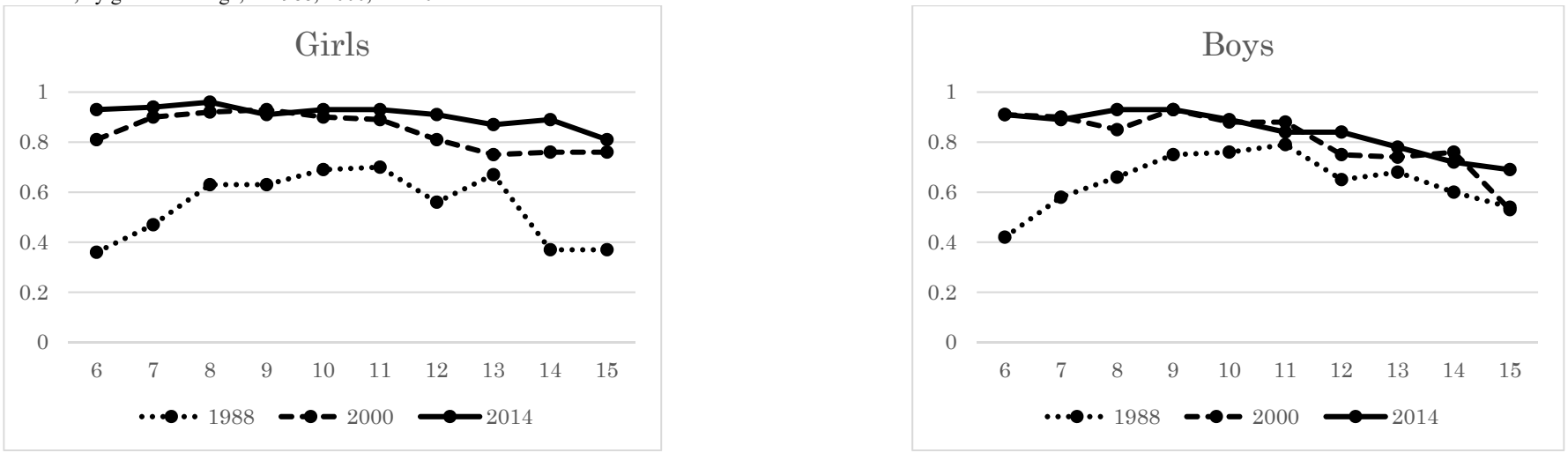
	(1) BW3	(2) BW4	(3) BW5	(4) BW6
Panel A: Total weekly expenditure				
Years of education	232.470***	765.663**	533.609*	437.918
	(86.656)	(319.580)	(300.313)	(325.089)
(Age – 30)	-38.832**	208.005*	54.769	57.412
	(17.426)	(123.587)	(127.132)	(98.262)
Constant	-1.4e+03**	-4.3e+03***	-4.5e+03***	-3.6e+03***
	(560.254)	(1661.025)	(1273.482)	(1084.494)
Observations (no.)	455	573	724	933
Mean of dep. var. on right of the cutoff	2999.03	3204.05	3177.43	3360.01
Panel B: Weekly expenditure on nutritious food items				
Years of education	85.584***	128.627***	121.786***	118.701***
	(23.421)	(42.856)	(29.367)	(34.738)
(Age – 30)	18.640**	33.741**	28.454***	17.879*
	(8.733)	(13.115)	(8.087)	(10.815)
Constant	113.215	-245.926	-204.190	-487.872**
	(252.555)	(353.627)	(242.468)	(202.297)
Observations (no.)	455	573	724	933
Mean of dep. var. on right of the cutoff	655.03	687.62	679.99	706.88
Panel C: Weekly expenditure on sanitation items				
Years of education	5.878***	6.954***	6.944***	5.319
	(1.565)	(1.597)	(2.554)	(3.979)
(Age – 30)	1.949**	2.146***	1.898**	1.172
	(0.867)	(0.515)	(0.740)	(1.155)
Constant	-17.274	-25.393**	-23.703*	-22.822*
	(13.838)	(12.425)	(12.654)	(13.080)
Observations (no.)	455	573	724	933
Mean of dep. var. on right of the cutoff	60.03	61.87	62.10	64.59
Panel D: Weekly expenditure on medical care				
Years of education	77.948**	139.460**	102.081	49.688
	(36.975)	(67.825)	(93.782)	(79.094)
(Age – 30)	11.298	34.174*	9.771	5.072
	(15.525)	(19.916)	(36.096)	(22.484)
Constant	-568.171**	-1.2e+03**	-1.0e+03**	-590.630
	(281.199)	(536.616)	(407.368)	(393.118)
Observations (no.)	455	573	724	933
Mean of dep. var. on right of the cutoff	155.01	184.79	193.12	212.85

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The number of family members in a household and husband's age are included in Panels A–D.

Figures

Figure 1

School enrollment rate, by gender and age, in 1988, 2000, and 2014

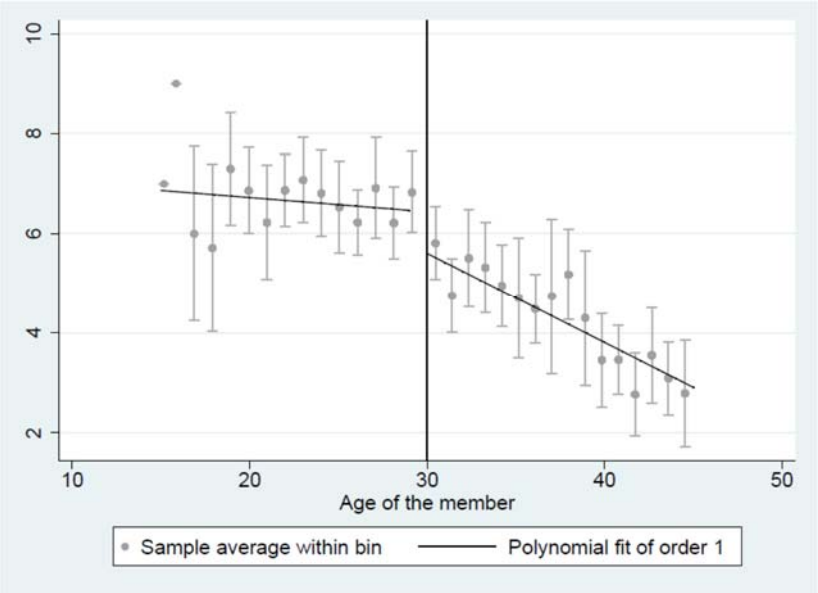


Source: Livelihood System of Rural Households Panel Data in 1988 and 2000

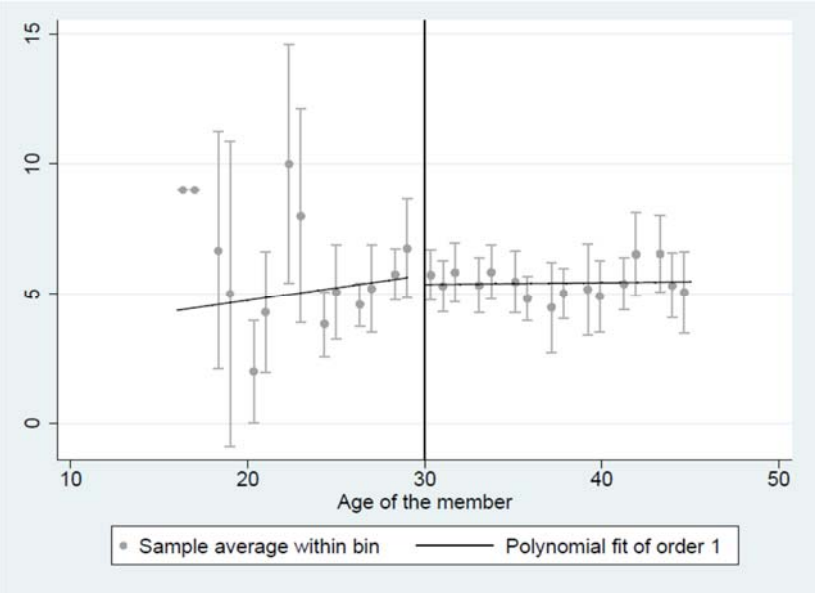
Note: X axis shows age; Y axis shows school enrollment rate

Figure 2
Average and scatterplots of years of education, by age

(a) Average years of education: Wife

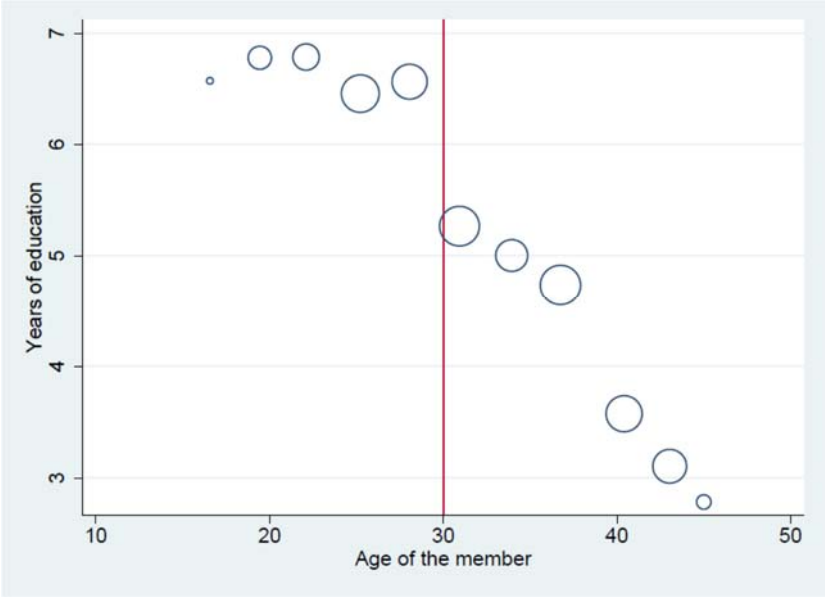


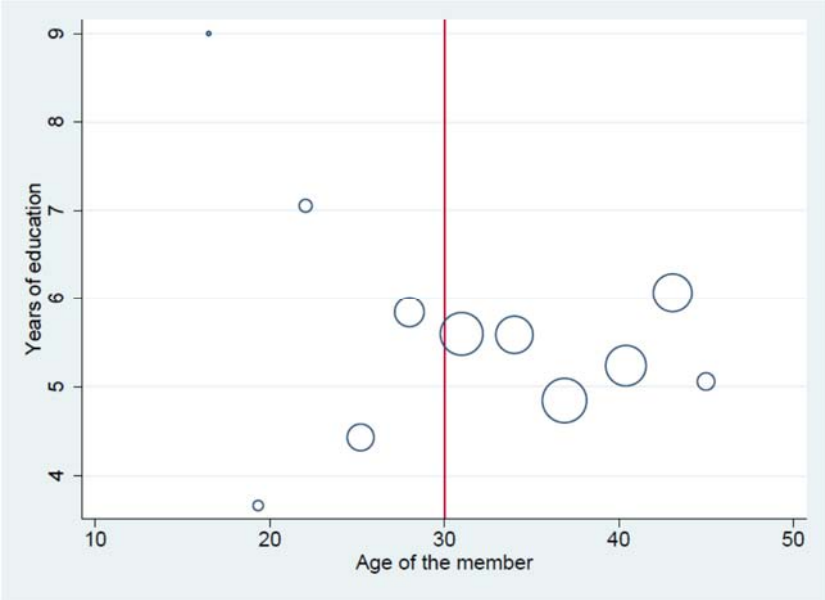
(b) Average years of education: Husband



(c) Scatterplots of years of education: Wife

(d) Scatterplots of years of education: Husband


Years of education
3
4
5
6
7
10
20
30
40
50
Age of the member

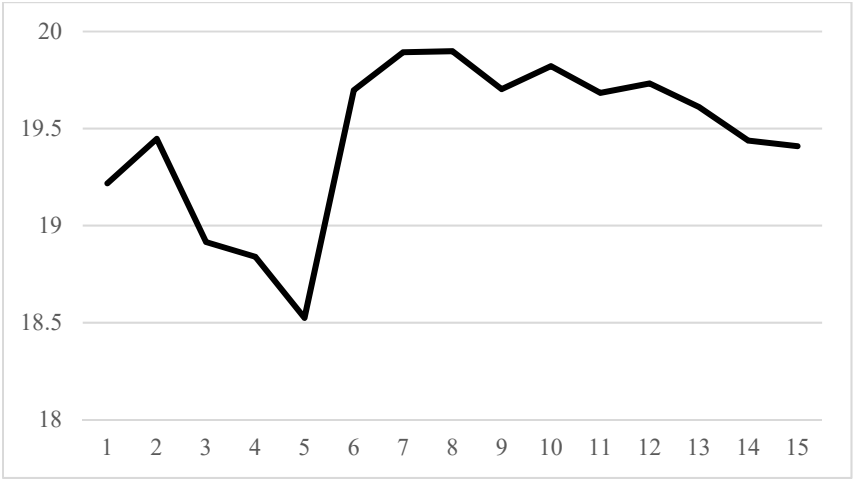

Years of education
4
5
6
7
8
9
10
20
30
40
50
Age of the member

Appendix Table A1
The Impact of Women's Years of Schooling on FLFP: All Women

	(1) BW3	(2) BW4	(3) BW5	(4) BW6	(5) BW7	(6) BW8	(7) BW9	(8) BW10
Panel A: The impact of the stipend program on years of schooling: First-stage results								
Treatment = 1	1.116*	0.912*	1.056**	1.029**	1.125**	1.315***	1.313***	1.137***
	(0.513)	(0.401)	(0.390)	(0.397)	(0.408)	(0.377)	(0.366)	(0.358)
Treat*(Age – 30)	-0.301	-0.311*	-0.120	-0.024	0.015	-0.094	-0.058	-0.007
	(0.248)	(0.145)	(0.095)	(0.091)	(0.088)	(0.084)	(0.074)	(0.068)
(Age – 30)	0.024	-0.098	-0.101	-0.153**	-0.146**	-0.066	-0.087	-0.137**
	(0.280)	(0.119)	(0.079)	(0.069)	(0.066)	(0.071)	(0.065)	(0.062)
Constant	3.853*	4.607**	3.587**	3.437***	3.485***	3.342***	3.493***	3.736***
	(1.882)	(1.731)	(1.119)	(0.848)	(0.811)	(0.630)	(0.608)	(0.609)
Observations (no.)	643	800	1048	1367	1531	1720	1898	2070
Panel B: The impact of years of schooling on FLFP defined by the occupation data: Second-stage results								
Years of education	0.001	-0.009	-0.033	-0.045	-0.026	-0.020	-0.010	-0.003
	(0.022)	(0.016)	(0.024)	(0.030)	(0.024)	(0.019)	(0.022)	(0.024)
(Age – 30)	0.007	-0.007	-0.010	-0.016*	-0.009	-0.007	-0.003	-0.002
	(0.009)	(0.004)	(0.008)	(0.008)	(0.006)	(0.005)	(0.006)	(0.006)
Age of head	0.001	0.002**	0.003**	0.004***	0.003***	0.002***	0.001	0.001
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.302***	0.273***	0.271**	0.217**	0.176*	0.163**	0.145	0.146
	(0.080)	(0.095)	(0.122)	(0.107)	(0.095)	(0.082)	(0.089)	(0.100)
Observations (no.)	641	797	1045	1360	1523	1711	1887	2057
Panel C: The impact of years of schooling on FLFP defined by the time allocation data: Second-stage results								
Years of education	0.005	0.032	0.015	-0.009	-0.047	-0.040	-0.034	-0.008
	(0.058)	(0.028)	(0.043)	(0.037)	(0.047)	(0.028)	(0.028)	(0.039)
(Age – 30)	0.018	0.035***	0.022	0.015	0.002	0.004	0.008	0.014
	(0.020)	(0.012)	(0.016)	(0.011)	(0.012)	(0.007)	(0.007)	(0.010)
Age of head	-0.001	-0.004	-0.003	-0.002	-0.000	-0.000	-0.000	-0.002
	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Constant	0.339	0.283	0.496***	0.570***	0.693***	0.724***	0.706***	0.628***
	(0.291)	(0.230)	(0.184)	(0.148)	(0.189)	(0.149)	(0.146)	(0.143)
Observations (no.)	487	604	770	1005	1105	1242	1334	1442

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Figure A1
Bandwidth selection: Cross-validation function



Note: X axis shows bandwidth.

Online Appendix

1. Attrition analysis

Online Appendix Table A1 shows the number of sample households, attrited households, and newly added households. Newly added households were included in the sample in later rounds to replace attrited households and expand the sample size (from approximately 20 households in each village in 1988 to 30 households in later years). Attrition rates are 19%, 7%, and 11% in 1988–2000, 2000–2008, and 2008–2014, respectively. Split households were split from the sample household in the previous survey round. For example, if one of the household members gets married and becomes independent from his/her natal household, then the newly established household will be counted as a split household. As the survey only tracks households in the sample villages, split households that left the sample village are no longer covered.

Online Appendix Table A2 presents the results of the probit estimation to identify the differences in characteristics between attrited households and others. The dependent variable is an attrited dummy, which takes one if a household went missing in the following survey rounds. Compared with remaining households, attrited households tend to have a household head with a secondary education and a head with no job. They also face capital constraints: the number of working-age male family members is smaller, and the amount of both owned land and non-land assets is less among attrited households. However, neither the education dummies nor the FLFP dummy are correlated with attrition status. For example, the coefficient of FLFP is 0.195 but statistically insignificant. Therefore, we decided not to apply attrition weights in our analysis.[17]

[17] Another concern with the data set is missing individuals. The data set is paneled at the household level rather than at the individual level. If a woman in the sample household leaves her natal village between survey rounds because of, for example, marriage or resettlement, she is no longer covered by the data in the later rounds. This characteristic of the data sets prevents us from exploring individual history by tracking the same person over time.

Online Appendix Table A1

Composition of Sample Households in Each Survey Year

Year	(1) Sample households in the previous survey	(2) Attrited households	(3) Newly added households	(4) Split households	(5) Total sample households = (1) – (2) + (3) + (4)
2000	1240	236(19%)	429	450	1883
2008	1883	132 (7%)	89	170	2010
2014	2010	229 (11%)	633	432	2846

Note: Attrited households = households that went missing in the following survey round

Online Appendix Table A2
Determinants of Attrition: Sample Women Aged 25–60
Dependent variable: Attrited household = 1

	(1) 1988
Age of the member	-0.032
	(0.034)
Age squared	0.000
	(0.000)
Primary	0.036
	(0.118)
Secondary	0.162
	(0.205)
Widow/separated/divorced	0.041
	(0.144)
FLFP	0.195
	(0.178)
Head: Primary	0.109
	(0.107)
Head: Secondary	0.273*
	(0.145)
Head: High secondary and above	0.021
	(0.206)
Head: Non-farm/Non-primary	0.024
	(0.117)
Head: Not working	0.439*
	(0.266)
Number of children aged 0–4	0.068
	(0.061)
Number of working age male members (15<age<61)	-0.114***
	(0.043)
1 = if living with parent(s)	0.011
	(0.126)
Log of loans	-0.005
	(0.010)
Log of non-land assets	-0.022*
	(0.013)
Owned land of hh (ha)	-0.163**
	(0.067)
1= if Muslim	-0.212
	(0.152)
Access to electricity	-0.090
	(0.147)
% of non-farm village labor force	0.008
	(0.011)
% of village women in the labor force	-0.004
	(0.005)
Travel distance to Upazila HQ	-0.004
	(0.012)
Chittagong	-0.264
	(0.254)
Sylhet	-0.068
	(0.186)
Barisal	0.006
	(0.200)
Khulna	-0.456***
	(0.154)
Rajshahi	-0.144
	(0.126)
Constant	0.411
	(0.672)
Observations	1038

Note: Attrited households = women's households that went missing in the following survey round, standard errors in parentheses, standard errors clustered at the village level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, Base head's education = Illiterate, Base head's occupation = Farming, Base division = Dhaka

2. Internal validity test

We present three standard validity checks of our identification strategy following Imbens and Lemieux (2008). First, we argue that treatment status is randomly assigned as it is determined based on individual age. An important assumption here is that no individual can manipulate treatment status, thus allowing us to use the stipend program as a natural experiment that solely affects female educational attainment. To ensure this assumption, we examine whether there is any discontinuity in the forcing variable, age, at the cutoff by using McCrary (2008) density test. Online Appendix Figures A1(a) and A1(b) show the results of the test for the sample in 2000 and 2014, respectively. Neither figure reveals any discontinuity around the cutoff.

There is, however, still a possibility of the manipulation of treatment status. For example, if parents of girls ineligible for the treatment because of their age anticipated the stipend program, they would intentionally delay their daughter's school entry year or repeat the grade to enable her to remain in an eligible grade when the stipend program was introduced. Unfortunately, there is no clear record of when the stipend program was officially announced to all regions; therefore, we cannot reject the possibility of intentional delayed entry or grade repetition among girls around the cutoff. As we discussed in Section 3, delayed entry and grade repetition are common in the sample; however, if they are systematically correlated with the timing of the stipend program, the assignment of treatment status is no longer random. To check whether there is any discontinuity in the probability of delayed entry and grade repetition, we create a dummy variable that takes one if a schooling child is in a lower grade than the grade she/he is supposed to be according to her/his age. Online Appendix Figure A1(c) presents the result. Although there is a slight jump between ages 15 and 16 at the cutoff, this may be because of the terminal exam after grade 10 (at ages 15 and 16) called the Secondary School Certification). As an individual who fails to pass the exam cannot proceed to the next grade, the number of grade repeaters is likely to increase at this age. Indeed, another jump is observed at around age 18 when students face another terminal exam, the Higher Secondary Certification.

To check that the jump in grade repetition and delayed entry occurs similarly in the other waves of the data, we also create the same figures using the data in 2008 and 2014. The data in 1988 were not used because the social awareness of the importance of girls' education as well as demand for female education (e.g., demand for a school certification) have been dramatically changed since the introduction of the stipend program (Schurmann, 2009). Online Appendix Figures A2(a) and A2(b) show the results

in 2008 and 2014, respectively. In both years, there is a clear jump around the same cutoff (age 16), which is similar to the result using the data in 2000. Thus, it is reasonable to conclude that the observed jump is less likely to be motivated by the stipend program. Rather, it is more likely to be derived from the terminal exam between grades.

Second, to ensure that the outcomes of interest are solely affected by the change in female schooling derived from the stipend program, we examine whether covariates that affect both educational attainment and the outcomes of interest show a discontinuity at the cutoff. Online Appendix Figures A3(a)–A3(d) present the pre-marital household characteristics of children in 2000: mother's years of schooling, father's years of schooling, amount of owned land, and log of non-land fixed assets. These characteristics could affect both women's schooling and their post-marital outcomes. Our data are paneled at the household level rather than not individually paneled. Therefore, we cannot track the pre-marital household characteristics of exactly the same study sample in 2014. Instead, we use our data on children in 2000, assuming that they share similar household characteristics to the study sample in 2014.[18] Although it is difficult to judge whether the observed discontinuity is acceptable, all four covariates in Online Appendix Figures A3(a)–A3(d) vary relatively smoothly around the cutoff according to the standard from a previous study using a similar methodology (Keats, 2018).

Third, to ensure that the stipend program only affects women's school attainment and that no change in men's education is induced, we examine Equation (3) using the men in our sample in 2014. Online Appendix Table A3 presents the results. The coefficients of treatment status are not significant and the F-statistics for the joint hypothesis of treatment status and the interaction term are small. Thus, we find no impact of the stipend program on male school attainment.

In addition to these three internal validity checks, we examine whether the probability of attrition is smooth around the cutoff as we use panel data. Since most women exposed to the stipend program were not yet born in the first wave of data in 1988, we instead use the second wave of data collected in 2000. As shown in Online Appendix Figure A4, there is no jump around the cutoff at age 16, meaning that our estimation is less likely to be distorted because of the incidence of attrition.

[18] We also do not know whether women were originally from the same sample village or moved from a non-sample village through marriage.

Online Appendix Table A3

The Impact of the Female Secondary School Stipend Program on the Husband's Years of Education: Results of the First-stage Regression

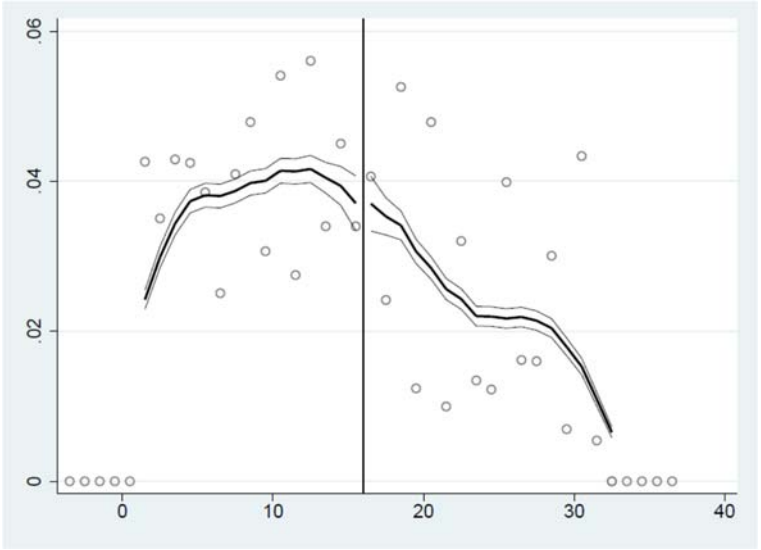
	(1) BW3	(2) BW4	(3) BW5	(4) BW6
Treatment = 1	0.420	0.555	-0.022	-0.020
	(0.578)	(0.531)	(0.636)	(0.534)
Treat*(Age – 30)	-0.262	-0.160	0.255	0.333*
	(0.375)	(0.181)	(0.237)	(0.168)
(Age – 30)	0.098	0.169*	-0.097	-0.167***
	(0.278)	(0.075)	(0.143)	(0.049)
Constant	3.107**	2.632**	2.724**	3.519***
	(1.121)	(1.074)	(0.968)	(0.874)
F statistics	0.34	2.81	0.59	2.91
Observations (no.)	338	426	517	643

Notes: Standard errors in parentheses. Standard errors clustered at the cohort level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

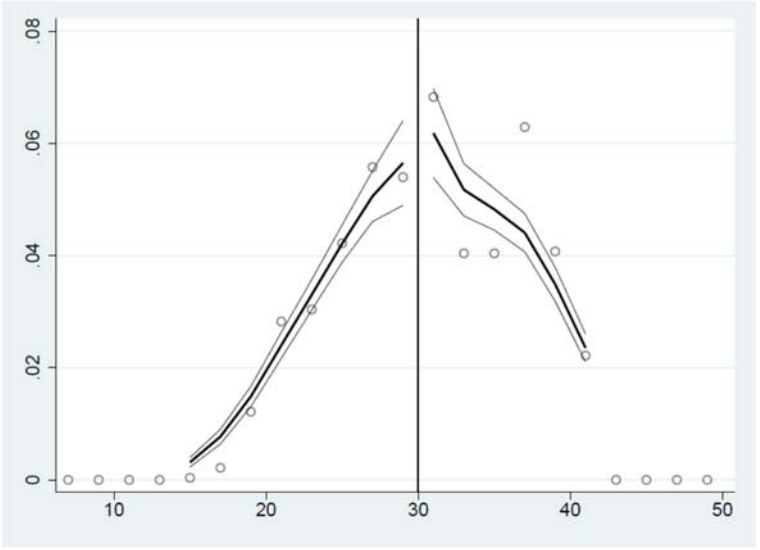
Online Appendix Figure A1

Density check in forcing variable: McCrary (2008) density test and discontinuity check in grade repetition and delayed entry

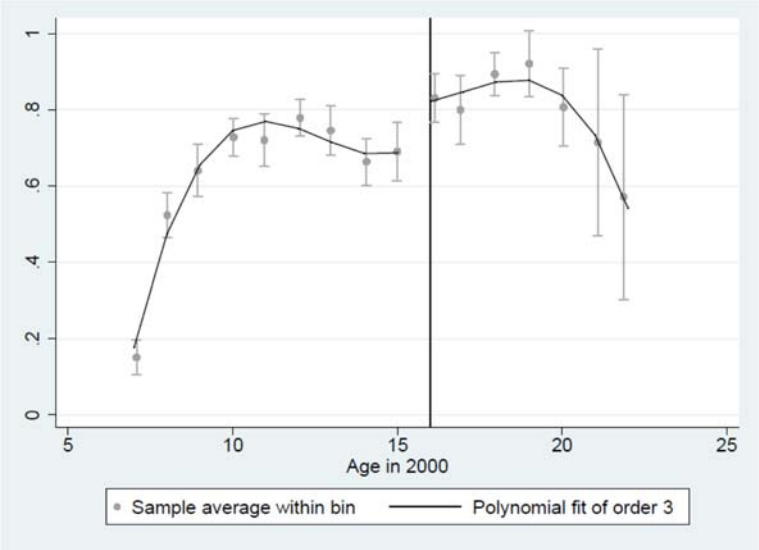
(a) McCrary (2008) density test with data in 2000



(b) McCrary (2008) density test with data in 2014



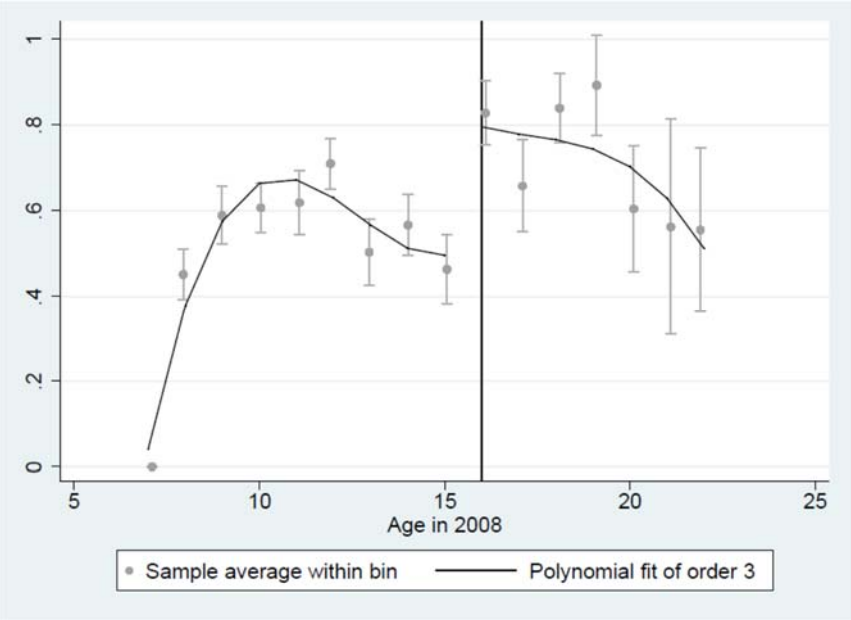
(c) Discontinuity check in grade repetition and delayed entry in 2000



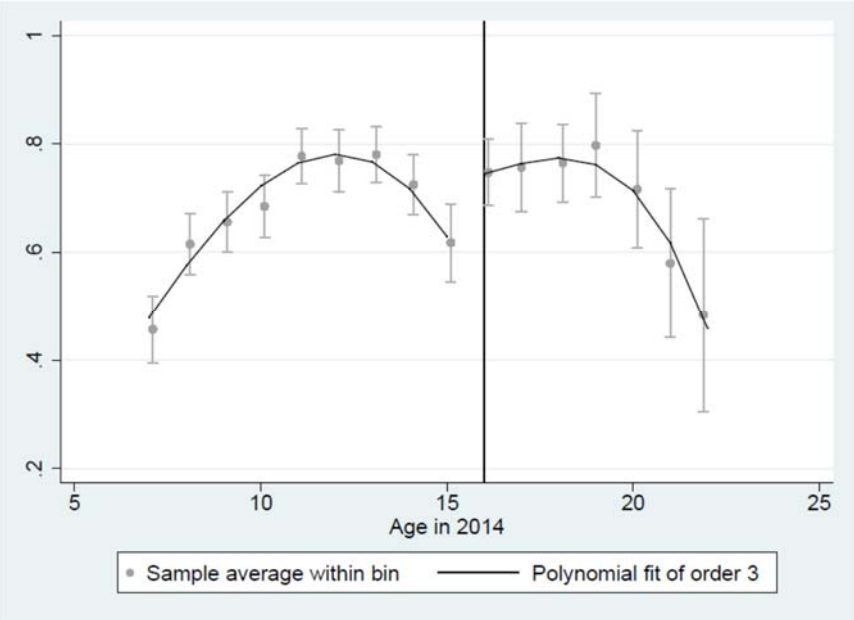
Note: X axis shows age. Vertical lines indicate cutoff at ages 16 and 30 in 2000 and 2014, respectively.

Online Appendix Figure A2
Discontinuity check in grade repetition and delayed entry

(a) Data in 2008



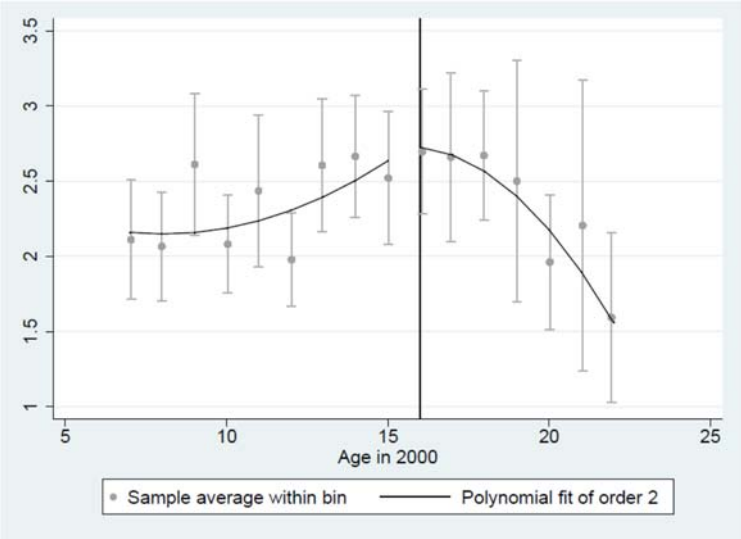
(b) Data in 2014



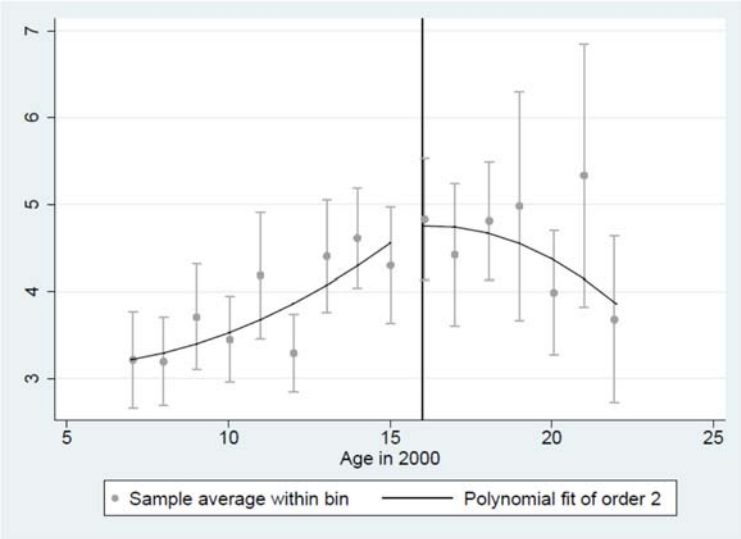
Online Appendix Figure A3

Discontinuity check in other covariates: pre-marital household characteristics in 2000

(a) Mother's years of schooling

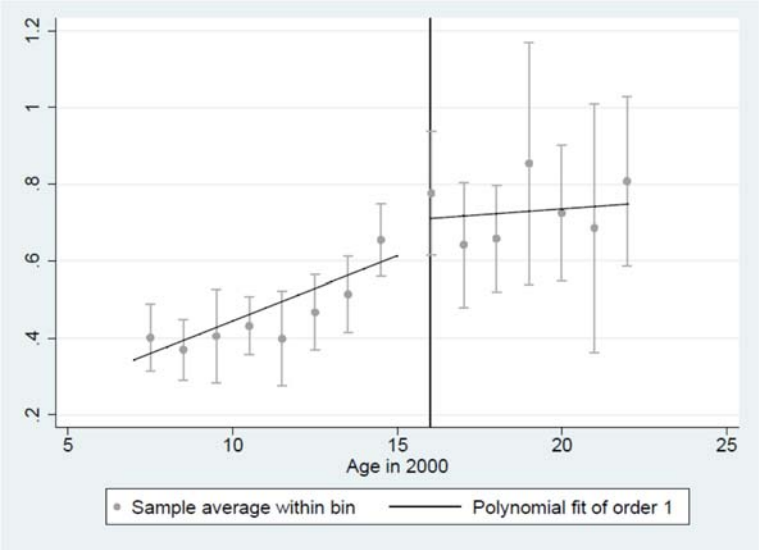


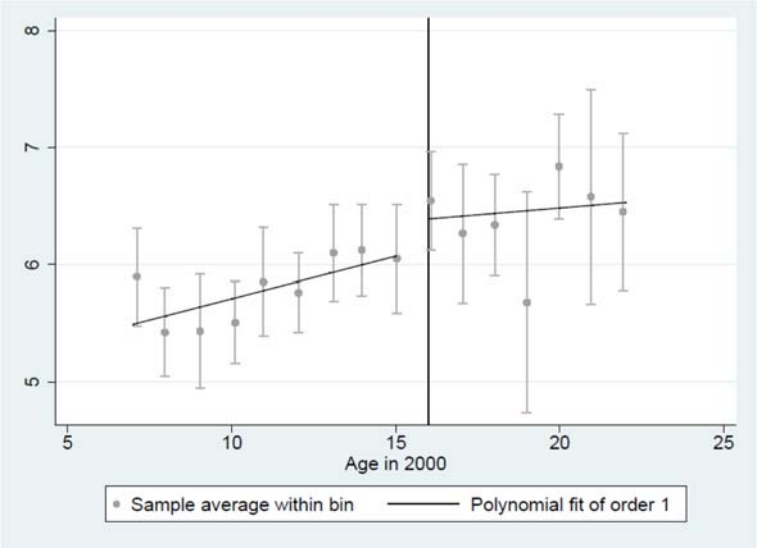
(b) Father's years of schooling



(c) Amount of owned land (ha)

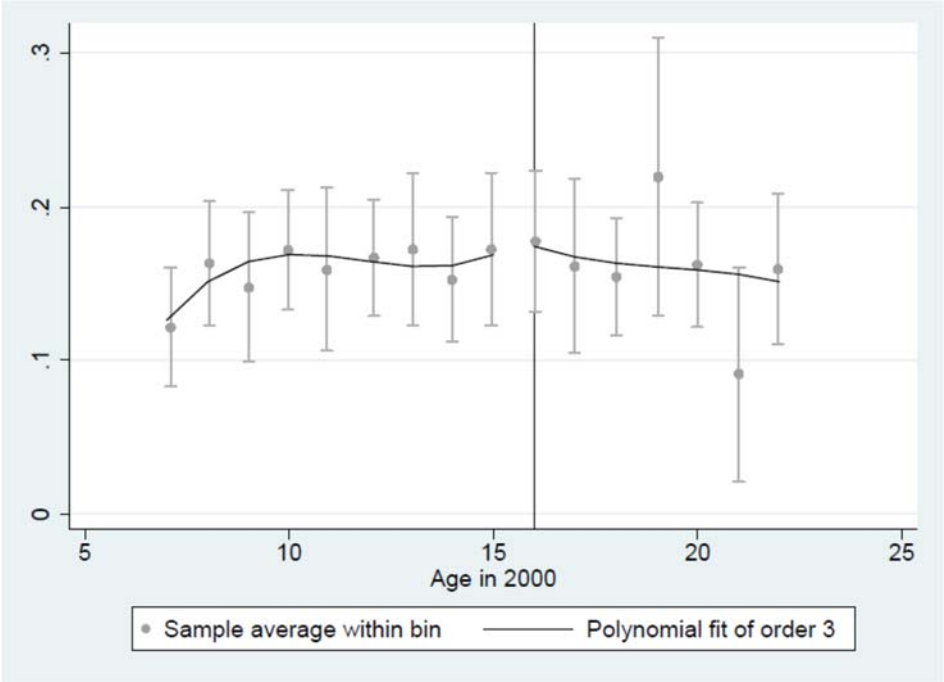
(d) Log of non-land fixed assets





Note: Vertical lines indicate cutoff at age 16.

Online Appendix Figure A4
Probability of attrition using the data in 2000



Online Appendix Table A4
Summary statistics and definition of the outcome variables

(1)	(2) Definition	(3) Mean	(4) Standard deviation
Wife's years of education	Years of schooling attained by wife aged 25–36	5.56	3.79
Age at marriage	Age at first marriage, for wife aged 25–36	17.33	2.66
FLFP dummy defined by occupation data	Dummy takes the value of one if wife aged 25–36 reported an income-generating activity as her primary or secondary occupation	0.09	0.28
FLFP dummy defined by time allocation data	Dummy takes the value of one if wife aged 25–36 reported that she spent at least one hour on an income-generating activity for the last four days, regardless of its actual payment	0.63	0.48
Husband's years of education	Years of schooling attained by husband whose wife aged 25–36	5.40	4.74
Per capita household income (100 Tk)	Per capita household income earned by family members except wife aged 25–36	236.98	201.46
Per capita household farm income (100 Tk)	Per capita household farm income earned by family members except wife aged 25–36	90.88	112.63
Per capita household non-farm income (100 Tk)	Per capita household non-farm income earned by family members except wife aged 25–36	146.10	194.39
Husband's foreign migration dummy	Dummy takes the value of one if husband whose wife aged 25–36 has ever migrated to a foreign country	0.08	0.27
Fertility by wife age 23	Number of children born by age 23 for wife aged 25–36	1.35	0.84
Schooling dummy for any family members aged 15–22	Dummy takes the value of one if any family member aged 15–22, who live in the same household with wife aged 25–36, currently attend school	0.64	0.48
Clean latrine dummy	Dummy takes the value of one if household where wife aged 25–36 lives uses a latrine with a water seal	0.57	0.50

Health dummy for children age 0–5	Dummy takes the value of one if children aged 0–5, whose mother is wife aged 25–36, reported that they are "sometimes sick" or "hardly ever sick" and zero if they reported they are "almost always sick"	0.93	0.25
Total weekly expenditure (Tk)	Total weekly expenditure in a household where wife aged 25–36 lives	3216.43	2880.98
Weekly expenditure on nutritious food item (Tk)	Total weekly expenditure in a household where wife aged 25–36 lives, spent on nutritious food such as fruit and vegetables, meat, and eggs	694.03	500.22
Weekly expenditure on sanitation items (Tk)	Total weekly expenditure in a household where wife aged 25–36 lives, spent on sanitation items such as soap, detergent, and related items	62.45	37.45
Weekly expenditure on medical care (Tk)	Total weekly expenditure in a household where wife aged 25–36 lives, spent on medical care and medicine	208.37	716.25